SOUTHERN ENVIRONMENTAL LAW CENTER

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October 8, 2020

Via Electronic Filing

The Honorable Jocelyn G. Boyd
Chief Clerk/Administrator
Public Service Commission of South Carolina
101 Executive Center Drive
Columbia, SC 29210

RE: South Carolina Energy Freedom Act (H. 3659) Proceeding Initiated Pursuant to S.C. Code Ann. Section 58-40-20(C): Generic Docket to (1) Investigate and Determine the Costs and Benefits of the Current Net Energy Metering Program and (2) Establish a Methodology for Calculating the Value of the Energy Produced by Customer-Generators

Docket Number 2019-182-E

Dear Ms. Boyd:

Please find attached for electronic filing the *Direct Testimony of Frank Hefner* filed on behalf of the South Carolina Coastal Conservation League (CCL), Southern Alliance for Clean Energy (SACE), Upstate Forever, and Vote Solar in the above-referenced matter.

Please contact me if you have any questions concerning this filing.

Sincerely,

/s/ Katherine Nicole Lee
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Attorney for South Carolina Coastal Conservation League, Southern Alliance for Clean Energy, and Upstate Forever

STATE OF SOUTH CAROLINA

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of: South Carolina Energy Freedom Act (H.3659) Proceeding Initiated Pursuant to S.C. Code Ann. Section 58-40-20(C): Generic Docket to (1) Investigate and Determine the Costs and Benefits of the Current Net Energy Metering Program and (2) Establish a Methodology for Calculating the Value of the Energy Produced by Customer-Generators	)))))))))))))	**DOCKET NO. 2019-182-E**

DIRECT TESTIMONY AND EXHIBITS OF

FRANK HEFNER, Ph.D

ON BEHALF OF

THE SOUTH CAROLINA COASTAL CONSERVATION LEAGUE, SOUTHERN ALLIANCE FOR CLEAN ENERGY, UPSTATE FOREVER, AND VOTE SOLAR

October 8, 2020

EXHIBITS

Exhibit A – An Economic Analysis of the Solar Industry in South Carolina prepared by Frank Hefner, Ph.D, and J. Wesley Burnett, Ph.D

Exhibit B – Economic Impact of the Solar Industry in South Carolina by Market Segment prepared by Frank Hefner, Ph.D

Exhibit C – Curriculum Vitae of Frank Hefner

I. Introduction and Qualifications

Q: PLEASE STATE YOUR NAME, POSITION, AND BUSINESS ADDRESS FOR THE RECORD.

A: My name is Frank Hefner. I am a Professor of Economics at the College of Charleston. My office address is Department of Economics, College of Charleston, Charleston, South Carolina, 29424.

Q: PLEASE SUMMARIZE YOUR PROFESSIONAL AND EDUCATIONAL QUALIFICATIONS.

A: I am the Director of the Office of Economic Analysis at the College of Charleston. I have been a Professor at the College of Charleston for 25 years. Prior to that I was a research economist at the University of South Carolina for eight years.

My teaching focuses primarily on macroeconomics and econometrics, the application of statistics to economic theory. My research focus is in the field of regional economics. I have published papers dealing with economic impact models and the evaluation of economic policies to state and local economies. I have also consulted for a number of clients, such as Volvo, where I analyzed the economic impact of firm’s operations.

I received a B.A. in economics from Rutgers College, and a M.A. and Ph.D. in economics from the University of Kansas. A copy of my curriculum vitae is attached as Exhibit C.

Q: HAVE YOU PREVIOUSLY FILED TESTIMONY AS AN EXPERT WITNESS IN A REGULATORY PROCEEDING?

A: Yes. I have provided expert opinions on economic impacts before the South Carolina Public Service Commission and United States District Court, District of South Carolina Columbia Division. In the Public Service Commission hearing, I commented on the economic impact of Bell South's request to provide InterLATA phone service. The case before the United States District Court involved a determination of the economic benefit to the South Carolina economy of procurement preferences in State government procurement contracts.

Q: ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A: The South Carolina Coastal Conservation League ("CCL"), the Southern Alliance for Clean Energy ("SACE"), Upstate Forever, and Vote Solar.

Q: ARE YOU SPONSORING ANY EXHIBITS?

A: Yes. I am sponsoring three exhibits. Exhibit A is an Economic Analysis of the Solar Industry in South Carolina authored by myself and J. Wesley Burnett, Ph.D. Exhibit B is my analysis of the economic impact that the solar industry in South Carolina by market sector, focused on the economic benefits of rooftop solar. Exhibit C is my curriculum vitae.

Q: WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY IN THIS PROCEEDING?

A: The purpose of my testimony is to explain and quantify the benefits that the solar industry, and rooftop net-metered solar in particular, have on the economy of South Carolina. Under a provision of the Energy Freedom Act, the Commission was directed to consider the direct and indirect economic impact of the net energy metering program to the State when evaluating the costs and benefits of the net energy metering program. S.C. Code Ann. § 58-40-20(D)(4).

II. <u>Economic Impact of the Solar Industry in South Carolina</u>

Q: WHAT KIND OF ECONOMIC IMPACTS DOES YOUR REPORT, ECONOMIC ANALYSIS OF THE SOLAR INDUSTRY IN SOUTH CAROLINA, CONSIDER?

A: The economic impact section of the report, which I authored, is attached to my testimony as Exhibit B.

The term "economic impact' includes: (1) direct impacts, (2) indirect impacts, and (3) induced impacts. Direct impacts are the purchase of local services, labor, and goods. For example, direct impacts include wages paid to the installers of solar panels. Indirect impacts, sometimes called the ripple effect, are the purchases of goods and services by the firms in South Carolina that install solar panels. Finally, induced impacts are the impact of purchases as a result of wages paid. For example, it is important to consider the purchases made possible by wages paid to solar workers, such as the groceries purchased by a solar panel installer. The total economic impact of an activity, or in the case of the solar industry a collection of activities, is the sum of all three of these impacts.

The solar industry also has environmental benefits and generates cost savings for customers. My report and analysis do not include these additional benefits.

Q: HOW DOES YOUR REPORT QUANTIFY THE ECONOMIC IMPACTS OF THE SOLAR INDUSTRY?

A: The report analyzed the economic impact of the solar industry in South Carolina by using direct impact values, namely job numbers, as inputs into a regional economic impact model. We input data from The Solar Foundation's annual survey of solar jobs into a regional impact model, IMPLAN, to assess the total economic impacts of jobs created by the solar industry in South Carolina.

Q: WHAT IS IMPLAN?

A: IMPLAN, or Impact Analysis for Planning, is a model commonly used to measure economic impacts. IMPLAN was initially developed by the United States Department of Agriculture Forest Service in the 1970s and is now maintained and marketed by a private firm. IMPLAN is a well-recognized impact model that is used by many researchers, including federal, state, and local governments, universities, and private companies. For example, Duke Energy itself used the IMPLAN model to calculate the economic benefits of its Grid Improvement Plan for North and South Carolina.

Through various statistical techniques, IMPLAN localizes the impacts of spending to a study area, here, the state of South Carolina. This means the impacts are completely within the state. IMPLAN accounts for "leakages", spending that leaves the state or region in the process and thus does not exert an impact.

Q: PLEASE SUMMARIZE THE RESULTS OF YOUR REPORT.

A: IMPLAN reports economic impact in terms of output, income and jobs. Output measures the total economic activity that takes place within the economy. Income includes employee compensation and proprietor's income. The Jobs category includes total jobs measured as full-time equivalents.

For calendar year 2018, IMPLAN calculated the total economic impact of the solar industry in South Carolina as $1,169,009,854, which supports 6,330 jobs. Total labor income generated by the solar industry and its impacts in 2018 amounted to $314,908,824.

For 2019, IMPLAN calculated the total economic impact of the solar industry in South Carolina as $1,538,920,852 which supports 7,250 jobs. Total labor income generated by the solar industry and its impacts in 2019 amounted to $389,719,789.

Q: HOW MUCH OF THE SOLAR INDUSTRY'S ECONOMIC IMPACT IN 2018 CAN BE ATTRIBUTED TO RESIDENTIAL SOLAR GENERATION?

A: I calculated the economic impact of the solar industry in South Carolina by market segment. These calculations are attached to my testimony as Exhibit B. I found that in 2018, the total economic impact of the residential segment of the solar industry was $655,814,528, which supports 3,551 jobs. Total labor income generated by the residential segment of the solar industry was $176,663,850.

Q: HOW MUCH OF THE SOLAR INDUSTRY'S ECONOMIC IMPACT IN 2019 CAN BE ATTRIBUTED TO RESIDENTIAL SOLAR GENERATION?

A: In 2019, the total economic impact of the residential segment of the solar industry was $863,334,598, which supports 4,067 jobs. Total labor income generated by the residential segment of the solar industry was $218,632,802.

Q: CAN YOU COMPARE THE ECONOMIC IMPACT OF THE SOLAR INDUSTRY TO ANY OTHER FIRMS?

A: By way of comparison the direct impact of the solar industry, which is widespread across the entire state, is approximately equal to the combined direct impact of the GE Power turbine plant in Greenville and the NUCOR Steel plant in Berkeley County.

Q: CAN YOU SUMMARIZE YOUR FINDINGS AND EXPLAIN WHY THEY MATTER IN THE CONTEXT OF THIS PROCEEDING?

A: My analysis demonstrates that the solar industry generally, and the residential segment of the industry specifically, has a significant positive impact on the economy of the state. A policy that fails to compensate residential solar development for the benefit it provides would undermine the solar industry's continued growth and limit the beneficial impacts that the industry has on the economy of the state.

Q: DOES THIS COMPLETE YOUR DIRECT TESTIMONY?

A: Yes.

CERTIFICATE OF SERVICE

I hereby certify that the parties listed below have been served with a copy of the *Direct Testimony of Frank Hefner* filed on behalf of the South Carolina Coastal Conservation League, Southern Alliance for Clean Energy, Upstate Forever, and Vote Solar by electronic mail or by deposit in the U.S. Mail, first-class, postage prepaid.

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This 8th day of October, 2020.

s/ Katherine Lee

Exhibit A

An Economic Analysis of the Solar Industry

in

South Carolina

Prepared by

Frank Hefner, Ph.D.

J. Wesley Burnett, Ph.D

Released August 27, 2020

SUMMARY

- In order to better understand the potential economic benefits of the Solar Industry to the state of South Carolina, the National Audubon Society commissioned this study to measure the economic impact of the Solar Industry.
- This report is divided into two sections. In the first section an analysis of the economic impact of the Solar Industry in the state of South Carolina is presented. The second section explores the adoption and non-adoption of solar photovoltaic (P.V.) energy in the state of South Carolina.

INDUSTRY HIGHLIGHTS

- Total U.S. solar energy generation provides enough power to meet the needs of 13.5 million American homes.
- Total installed .V.P.V. capacity in the U.S. is expected to double over the next five years.
- South Carolina is currently the fifteen largest producer of solar energy in the U.S.; however, it has one of the highest growth rates of solar penetration in the nation.
- The inconsistency of adoption among some electric co-ops to adopt net metering may present an impediment to the growth of solar energy adoption in South Carolina.
- South Carolina's residents' lack of trust in investor-owned utilities is creating an impediment to solar adoption.
- Rooftop solar systems are increasingly becoming cost-competitive with non-renewable energy sources.
- Strong net metering policies are integral for further solar adoption.
- Battery storage technologies are becoming an industry standard for rooftop solar.

INDUSTRY IMPACTS IN SOUTH CAROLINA 2019

- Solar energy has a $1.5 billion impact, including net-metered solar and utility-scale solar.
- Solar energy supports 7250 jobs.
- Annually, the solar energy industry contributes over $58.8 million in state and local taxes.

AN EXPLORATION OF SOLAR PHOTOVOLTAIC ADOPTION AND NON-ADOPTION IN SOUTH CAROLINA

This section offers an exploration of the adoption and non-adoption of solar photovoltaic (P.V.) energy in the state of South Carolina. More specifically, we examine the State's: (i) current policy environment; (ii) trends in .V.P.V. adoption (including national trends); (iii) potential reasons for non-adoption; (iv) economic impacts; (v) costs and benefits of solar; and, (vi) challenges and opportunities in the near- and long-term. Barring any adverse economic events, we predict that South Carolina's consumption of solar photovoltaics (coupled with storage) will likely follow the national trend and double by the end of the decade.

1 INTRODUCTION

A photovoltaic (P.V.) cell, or solar cell, is a non-mechanical device that converts sunlight directly into electricity. A PV cell is made of semiconductor material that converts photon energy from natural sunlight into electrons that are dislodged from the material's atoms. Electrical conductors on the cell absorb these electrons, and, these conductors provide an electrical current to an external load, such as a battery.

The current efficiency of residentially and commercially available .V.P.V. modules averages about fifteen percent (U.S. Energy Information Administration, 2018a). This level of efficiency is far greater than the ten-percent efficiency level of .V.P.V. modules offered in the mid-1980s.[1] The efficiency of the panel is important because the more efficient the unit, the more energy output it will produce per amount of light energy hitting the cell, which, in turn, will affect the surface area needed to meet energy requirements. A larger surface area translates into higher

[1] An efficiency level of fifteen percent is incredible considering that solar rays are not always coming in contact with the panel surface (for example, when it is dark or cloudy outside). To put this efficiency level into context, a conventional gasoline-powered vehicle converts about seventeen percent of the dense energy stored within gasoline to provide motive power to the automobile.

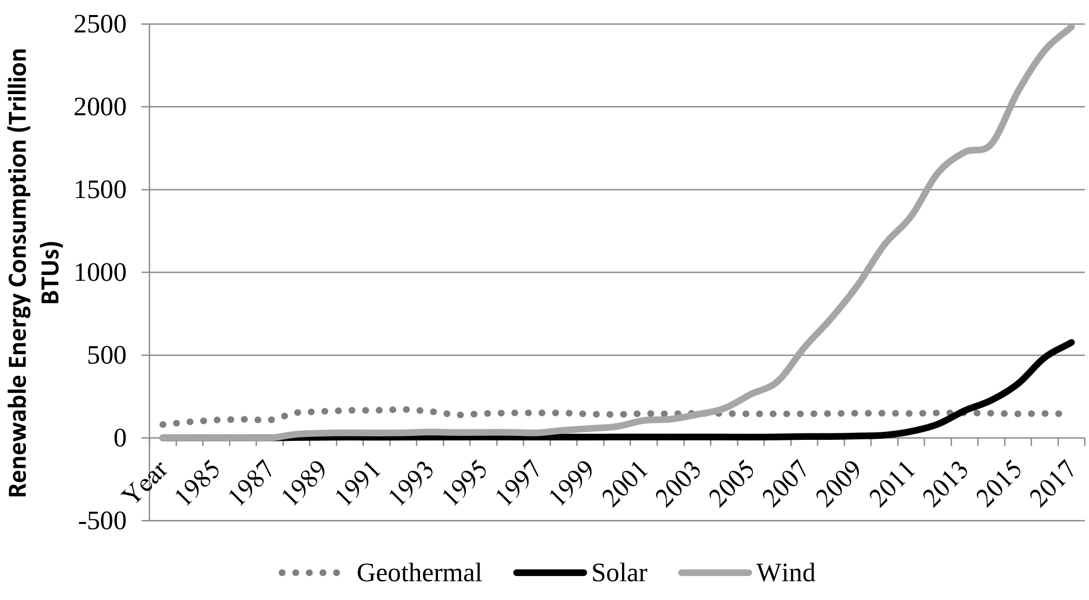
initial investments needed for the residential or commercial client. Further details about the costs of .V.P.V. adoption are explored below.

1.1 National Trends in .V.P.V. Energy Adoption

According to the Solar Energy Industries Association (2019), the .S.U.S. has reached 71.3 Gigawatts (G.W.) of total installed capacity, which provides enough power to meet the needs of 13.5 million American homes. Moreover, total installed .V.P.V. capacity is expected to double over the next five years.

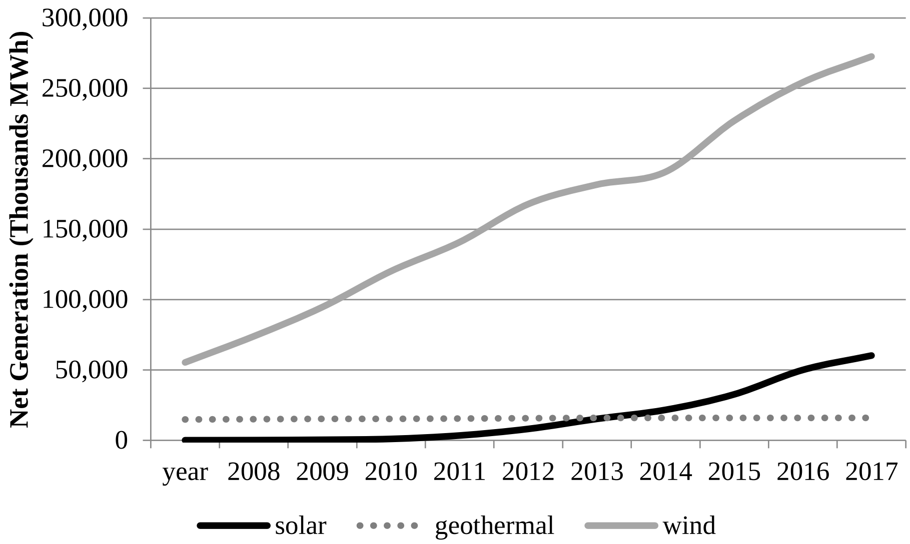
The recent increase in .V.P.V. capacity is part of a larger overall trend in installed non-hydroelectric renewable energy consumption in the U.S. Figure 1 offers a depiction of annual energy consumption from wind, solar, and geothermal from 1985 to 2018. As illustrated in the figure, solar and wind have grown by orders of magnitude since the year 2000. Specifically, energy consumption from solar P.V.s consisted of 12 billion British Thermal Units (BTUs) in 2010 and reached nearly 600 billion BTUs by 2018 – a 4800 percent increase in less than ten years. During that same period, net generation from solar P.V.s increased from 423 Gigawatt hours (GWhs) in 2010 to 60,000 GWhs by 2018 (as illustrated in Figure 2).

Figure 1. Renewable Energy Consumption Within the Electric Power Sector (1985-2018)



Source: (U.S. Energy Information Administration, 2020b)

Figure 2. Net Generation from Renewable Sources (2008-2018)



Source: (U.S. Energy Information Administration, 2020c)

2 U.S. RENEWABLE ENERGY POLICY AND INDUSTRY

Solar energy is increasingly becoming competitive with fossil fuel forms of energy. Many skeptics claim that this competitiveness is driven by federal and state subsidies. The best way to compare solar energy to fossil fuels without subsidies is to examine global energy prices. Globally, fossil fuel steam-generated electricity averaged around 5 cents per kilowatt-hour, and small-scale natural gas-generated electricity can cost as little at 3 cents per kilowatt-hour. However, a major commercial solar installation bid in a price of 2.9 cents per kilowatt-hour (EnergySage, 2019).

Moreover, the U.S. Energy Information Administration recently released the Annual Energy Outlook 2020 report in which they calculated the levelized costs (the costs of generation per megawatt-hour) for renewable versus fossil fuel energy. This report found that on a levelized cost basis (with and without tax credits), solar photovoltaic energy will be cheaper than all other technologies (including natural gas combined-cycle and onshore wind) for new generation resources entering service in 2025 (U.S. Energy Information Administration, 2020a).

The uptake of non-hydroelectric energy in the .S.U.S. has been driven in part by federal and state renewable energy policies. Federal policies include the investment tax credit, the production tax credit, the Clean Power Plan, Modified Accelerated Cost Recovery System Depreciation Schedule, and the .S.U.S. Department of Energy loan program, among others. State drivers include renewable portfolio standards, renewable energy certificates, net metering, carbon markets, state tax credits, property assessed clean energy programs, property tax exemptions, and state sales tax exemptions, among others.

Today, about 29 states and the District of Columbia (D.C.) have some form of a renewable portfolio standard (or renewable portfolio goal) policy (Database of State Incentives for Renewables & Efficiency, 2020). Of these adopters, 23 states have a provision for solar and/or distributed generation. Distributed generation consists of small-scale technologies used to produce electricity close to the end-users of power. Some of these technologies include modular generators and battery storage. Moreover, 44 states and D.C. have provisions for net metering.

Net metering is a billing mechanism that credits solar energy system owners for the electricity they add to the grid. For example, if a residential customer has a solar .V.P.V. system on the roof, it may generate more power than the home needs during daylight hours. Therefore, the owner can receive credit for this excess capacity back to the utility.

Net metering policies create the foundation for rooftop solar and storage system adoption. A recent survey of the literature conducted by the Brookings Institution found that the benefits of net metering far outweigh the costs and impose no significant cost for non-solar customers (Muro and Saha, May 23, 2016). These findings are the consensus of numerous studies conducted by public utility commissions, national labs, and academics.

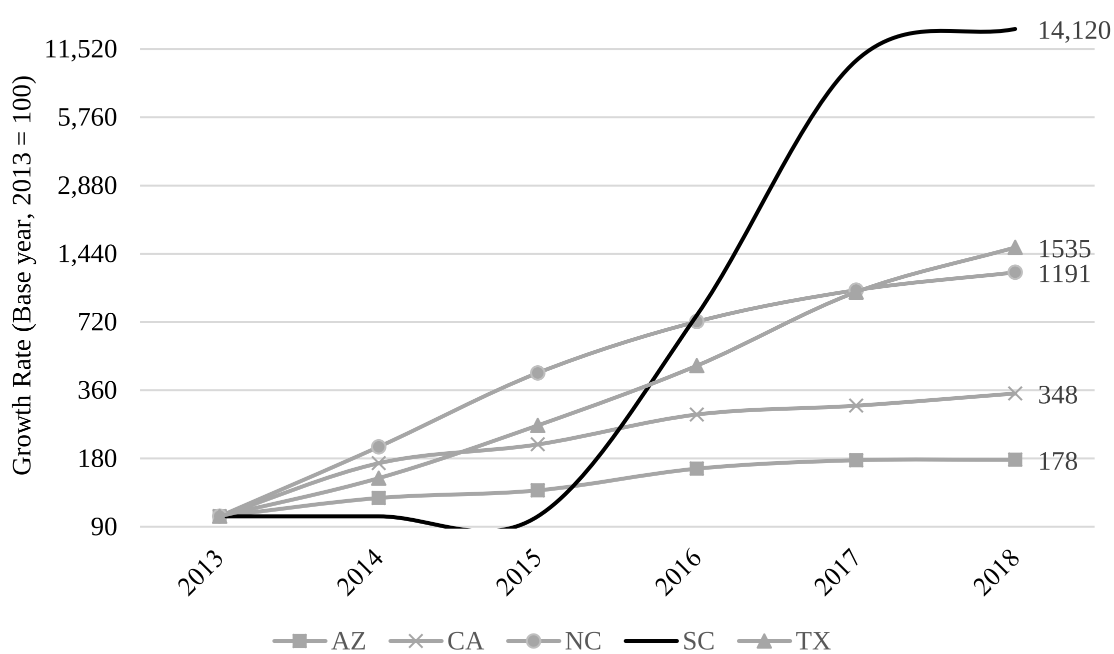
Wholesale level sales (the sale of electricity by generators to utilities) are regulated by the Federal Energy Regulatory Commission (FERC). On the other hand, retail-level sales (the sale of electricity by utilities to the general public) are regulated by state public utility commissions. Facilities usually qualify for a broad set of exemptions from FERC regulations under the 1978 U.S. Public Utility Regulatory Policies Act (PURPA). General facilities that are exempted from

FERC regulations under PURPA are called “qualifying facilities.” To meet the requirement of a qualifying facility, the system must generate at least seventy-five percent of the power from renewable energy. Rooftop solar systems easily meet the size and fuel use requirements. A typical rooftop system is under one megawatt in size, which is deemed as a qualifying facility with the protection of PURPA.

Currently, the top four producers of energy from solar P.V.s are California, North Carolina, Arizona, and Texas. South Carolina is the fifteen largest producer in the U.S.

South Carolina was slower than the top four adopters to embrace solar power; however, the State has one of the highest growth rates of solar adoption in the country. As displayed in Figure 3, South Carolina’s growth rate in solar exceeds 14,000 percent since 2013. During that same period, the growth rates in North Carolina and Texas’ were about 1200 and 1500 percent, respectively. The higher growth rate in South Carolina partially stems from a lack of solar infrastructure development before 2013, whereas California, Texas, and Arizona had significant existing capacity by that time.

Figure 3. The Growth Rate of Total Electric Power from Solar Energy by State (2013-2018)



Source: U.S. Energy Information Administration (2018b)

2.1 South Carolina Renewable Portfolio Standards

The state of South Carolina does not have a comprehensive renewable portfolio standard, but rather a goal for distributed generation by 2021 (National Renewable Energy Laboratory, 2018). The Distributed Energy Resource Program Act of 2014 established programs such as rebates and shared solar programs for investor-owned utilities including Duke Energy and Dominion Energy South Carolina (formerly South Carolina Gas and Electric). The program specifies that one percent aggregate capacity should come from renewable energy facilities sized one-to-ten megawatts (M.W.s), one percent from facilities of less than one M.W., and 25 percent from systems less than 20 kilowatts (kWs).

The state's net metering program applies to all utilities with more than 100,000 customers, and the provision does not allow the utilities to charge fees to net-metering customer generators until 2021. A report by the Clean Energy Group (2019) found that while the State's net metering policies were favorable, the State has provided little incentives to support customer-sited battery storage. Specifically, this report finds that solar plus storage would be a cost-effective solution for most facilities (including residential and commercial) based on electric bill savings alone.

The South Carolina legislature passed the Energy Freedom Act in May 2019. This act created a comprehensive solar bill that lifted the state's two-percent cap on net metering. The act also removed the two-percent cap on solar leasing and added provisions to ensure that community solar programming is addressing the needs of low-to-middle income customers. Moreover, the act offers reforms to integrated resource planning, in which utilities are required to present multiple resource and cost scenarios to regulators for their long-term resource plans (Morehouse, May, 10, 2019). Lastly, the act provides for a "customer bill of rights" that gives solar customers greater ability to control, such as time-of-use rates, their utility bills. As part of these rights, the new bill allows for net energy metering services to continue through May 31, 2029.

2.2 Non-Adoption of Solar Energy Among Residential Consumers

The Yale Center for Business and the Environment recently conducted a study of why South Carolina households chose not to adopt solar energy (Quiroz, January 24, 2019). This study listed a few main challenges to solar adoption. First, residents were concerned about unsupportive legislation that would lead to limited savings. However, with the passage of the Energy Freedom Act, this should not continue to be a concern for households.

The Yale study also identified the scattered territory divisions within the State as problematic for solar energy adoption. There are approximately 20 electric co-ops that provide electrification in rural areas. Every co-op has different rules regarding solar energy, and some are unwilling to accept solar installation. This patchwork of service territories creates problems for solar outreach programs.

Last, the Yale study found that South Carolina residents mistrust utility companies after the V.C. Summer Nuclear Generating Station was abandoned. Thus, even if utility companies offer incentive programs for solar adoption to its customers, households are fearful that the utilities will not be deliver on the promised incentives.

3 THE COSTS AND BENEFITS OF SOLAR PHOTOVOLTAICS IN SOUTH CAROLINA

Residential solar .V.P.V. systems often require a significant initial investment for a household. However, these systems qualify for a number of rebates, tax credits and other incentives that can significantly defray the initial costs. As an example, consider the costs and rebates, offered in Table 1, for a $20,000 system in South Carolina. In this example, the net cost of solar panel installation is nearly 61 percent less than the gross costs, due to cash rebates, state tax credits, and the federal investment tax credit (ITC).[2,3] From 2016 to 2019 the federal ITC allowed claims

[2] Approximately half of all residential, rooftop solar systems in South Carolina are leased. Lessees may not be eligible to receive the state tax credit.
[3] Manufacturer cash rebates may no longer be available at the time of this report.

up to a maximum of 30 percent (of the total estimated cost of a system); in 2020, the tax credit was reduced to 26 percent; and, in 2021, the credit reduces further to 22 percent. After 2022, owners can only claim 10 percent of the costs towards the tax credit.

Net metering allows customers to reduce the costs of the system even further. The two largest investor-owned utilities in South Carolina, Dominion Energy and Duke Energy, allow for net metering, in which a home or commercial enterprise can "bank" any excess produced power and sell it back to the utility. As of now, Dominion and Duke Energy offer "one-to-one" or "full retail" net metering through 2025 (S.C. Energy Office, 2020). One-to-one net metering means that the electricity produced by customers is equal in value to the electricity produced by a utility. For example, if a customer pays $0.10 per kWh for electricity from a utility, then the utility will give credit for any excess power produced by the customer at $0.10 per kWh.

Table 1. Costs and Rebates for a $20,000 S.C. Residential Panel System

Costs, Rebates, and Incentives	**Cost of System**	**Explanation**
Initial gross costs	$20,000	
Deduct cash rebates	-$2,000	Rebates vary by installer
Net costs after rebates	$18,000	
Deduct federal ITC	-$5,200	Up to 26% of the total cost
Deduct state tax credits	-$5,000	Up to 25% of the total cost
Net total cost of system	**$7,800**	

Notes: Federal tax credits and cash rebates are subject to change over the next couple of year. Therefore, the predicted savings may be smaller than what has been presented here.

Unlike other states, South Carolina does not currently offer any property (or sales) tax abatements for solar electric systems. For example, residential adopters in North Carolina receive an exemption from property taxes for one hundred percent of the appraised value of the installed system (all other systems receive an exemption for eighty percent of the appraised value).

In addition to cost savings, solar panel systems offer numerous environmental benefits. That is, solar energy helps to reduce air pollution, water usage, and dependence on non-renewable energy sources.

Wiser et al. (2016) estimated that solar energy offers human health benefits. Specifically, they found that the use of solar energy can prevent 25,000-59,000 premature deaths through improved air and water quality. In total, Wiser et al. (2016) monetized the environmental health benefits of solar as approximately $0.035/kWh to the value of solar energy. Finally, this report argues that if 14 percent of U.S. electricity demand is met by solar in 2030, then it could reduce cumulative power-sector greenhouse gas emissions by 10 percent between 2015 and 2050.[4] This reduction in emissions would save the U.S. approximately $250 billion in damages associated with climate change.

4 SOLAR PV INDUSTRY CHALLENGES AND OPPORTUNITIES OVER THE NEXT DECADE

As discussed in the Introduction, the adoption of solar energy is likely going to continue to double over the next decade. However, this growth will also likely present several new challenges and opportunities for the industry.

One of the more likely trends is that storage will become standard with solar installations (Cinnamon, January 3, 2020). As state renewable portfolio standards' (or goals) guarantees for net metering rates expire, more customers will demand full-service solar and storage offerings. In addition to the expiration of guarantees, industry trends are expected to evolve with: a decline in battery costs (National Renewable Energy Laboratory, 2020); increasing grid-service capabilities such as blockchain technologies and microgrids (Lawrence Berkeley National Laboratory, 2019); and, utility power may become increasingly more unreliable (U.S. Department of Energy, 2016).

As storage is now becoming standard with solar .V.P.V. systems, the industry will have to adopt new cost metrics. That is, adding battery storage will not only increase the over cost of the system, but it will also change the energy savings calculations (Bloch, et al., 2019). A recent

[4] As of 2018, approximately 2.3 percent of U.S. total energy production is generated by solar energy, including residential- and utility-scale PVs, and thermal solar energy.

study in California found that if an average residential rooftop solar customer combined battery storage with time-of-use rates, then it could save the customer as much as $2,200 per year and generate an investment rate of return of eighteen percent (Renewable Energy World, 2017).

Another prediction is that the underlying software will ultimately determine the future sales of solar systems. In other words, solar and storage contractors will select systems based on software capabilities, including customer apps, management interface, and utility interface. Regardless of the capabilities and efficiency of the hardware, systems will not sell without user-friendly and scalable software (Cinnamon, January 3, 2020).

As of now, there is no standard energy system interface between various distributed energy resources, including storage, solar, electric vehicles, HVAC systems, and lighting, among others. Instead, each of these components generally comes equipped with the manufacturer's developed applications or software systems. These piecemeal software solutions raise issues of data security and non-integration between devices. The lack of integration between devices will become more problematic as solar, storage, and DERs continue to proliferate.

Finally, the demand for solar energy and storage within the commercial and industrial sectors will continue to expand over the next decade. As displayed in Figure 4, solar energy consumption within the commercial sector was about half of the demand of the residential sector in 2019, but the commercial sector is catching up. Solar energy and storage adoption within the commercial and industrial sectors can take advantage of economies of scale and more efficient supply chains than residential systems (Goodrich et al., 2012). As such, these two sectors are expected to grow substantially within the next two years.

4.1 Opportunities for South Carolina over the Next Decade

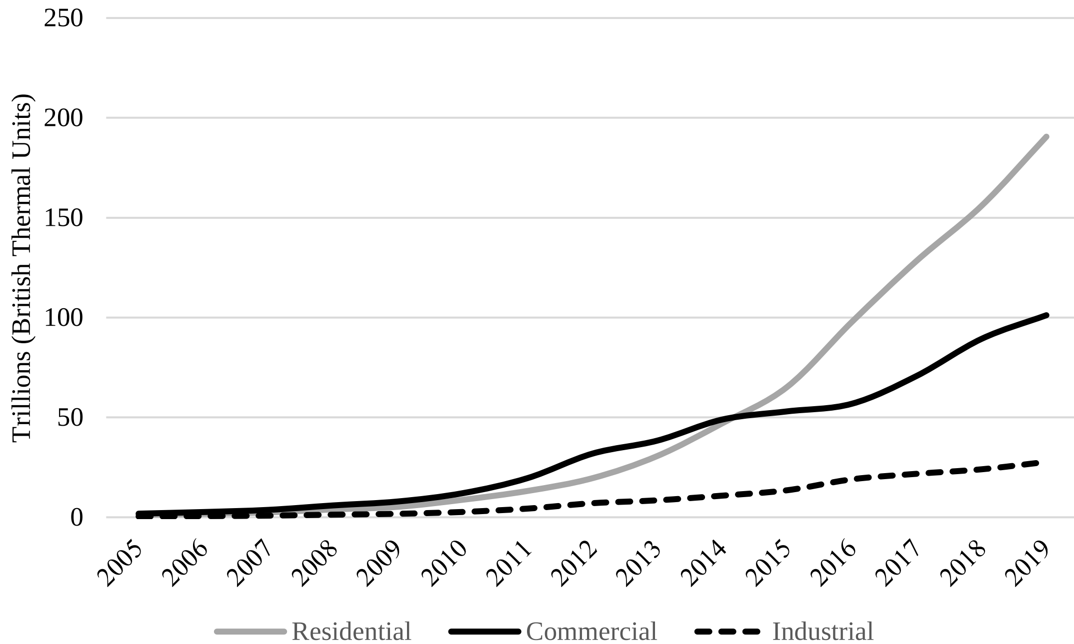
Despite having some of the highest installed costs, North Carolina has one of the highest installed photovoltaic capacity per person in the entire nation (Barbose et al. 2012). North Carolina's growth in solar energy has been driven by a series of state policies intended to foster energy efficiency and renewable energy. In part, this was due to solar-friendly provisions, such as fast-tracking applications smaller than two megawatts in size. The state adopted progressive net-metering regulations and interconnection standard by 2009, which removed limits on aggregate customer participation. Moreover, investor-owned utilities were required to offer net metering, and there was no limit on capacity. Lastly, the state's legislation created exemptions from property taxes as nonbusiness personal property.

What can South Carolina learn from North Carolina's example? One, strong net metering policies form the foundation for residential solar adoption. North Carolina created its net metering policies early and revised the policies to drive growth.

Two, the provision for fast-tracking applications can have a tremendous impact on residential and commercial uptake. According to the S.C. Energy Office (2018), the total length of time of installation, from ordering equipment to commissioning, is about three months. This estimate does not include sales, customer service, inspection, permitting, contract procurement, and interconnection (among others). Hence, a more realistic time frame, from the initial visit to the final installation, is longer than six months. Given the substantial upfront investment, customers (particularly in a state where customers do not trust investor-owned utilities) may become nervous and choose to forego adoption with such long lag times.

Three, South Carolina needs to develop more market-enabling policies, such as reducing interconnection delays. Krasko and Doris (2012) found that market preparation (interconnection) and market creation (renewable portfolio standards with solar set-asides) were the two main determinants of state-level solar adoption. For example, North Carolina formed a task force to develop smaller generator interconnection standards that would be consistent with national best practices (Steward et al., 2014). The solar industry has now created streamlining tools, such as the "SolarApp" campaign, which is an automated permitting process (Solar Foundation, 2019). SolarApp was designed to improve permitting, inspection, and interconnection by automating simple tasks, which arguably add an additional $7000 to the cost of a typical residential solar energy system.

Figure 4. Distributed solar energy consumption for electricity by sector (2005-2019)



Source: U.S. Energy Information Administration (2020c).

4.2 Challenges created by the novel coronavirus and its impact on the solar industry

According to a recent Solar Energy Industries Association (2020) report, the novel coronavirus will cause significant economic damages to the solar industry in South Carolina. The report states that the industry will face a 31 percent reduction in the workforce because of the pandemic (the total losses nationwide could be as high as 100,000 jobs in this industry alone). Moreover, the report finds that there will be 24 percent less solar capacity installed than pre-COVID forecasts. Similar to other industries nationwide, the solar industry experienced substantial losses in the second quarter, resulting in a $3.2 billion loss of investment in 2020 thus far.

ECONOMIC IMPACT

1 INTRODUCTION

Economic impact assessments are conducted routinely for a number of economic activities. Studies have been performed on the impact of such diverse activities and enterprises as tourists, factory start-ups and closings, and universities. The basic objective of an economic impact study is relatively straightforward - to measure the increase in a region's economic activity attributable to the presence of the enterprise or, in this case, the collection of activities that comprise the Solar Industry in South Carolina.

The term "economic impact" includes three basic elements:
1. Direct impact: the purchase of local services, labor, and goods. For example, wages paid to the installers of solar panels.
2. Indirect impact: Often called the ripple effects, these are the purchases of goods and services by the firms in South Carolina that install solar panels.
3. Induced impact: This is the impact of purchases as a result of wages paid. The groceries purchased by the installer on his or her way home are an example of an indirect impact.

The total economic impact is the sum of all three impacts. This total is often referred to as the multiplier effect and includes all the "spillover" effects. To calculate the total economic impact, the direct impact values are used as inputs into a regional economic impact model.

The purpose of this analysis is to measure the economic impact in the state of South Carolina of the businesses related to Solar Energy. What this analysis does not do? The analysis and data in this report do not include the environmental benefits nor the cost savings from Solar Energy. Economic impact includes both the direct, indirect, and induced economic activity by all of the types of businesses associated with the installation and maintenance of Solar Energy and the supply chain connected to those businesses.

The Solar Foundation conducts an annual survey of solar jobs. Using the data from this survey as inputs into a regional impact model, IMPLAN, the total economic impacts of solar jobs can be determined in South Carolina.

2 THE SOLAR INDUSTRY IN SOUTH CAROLINA

The Solar Industry is a multifaceted industry that encompasses manufacturing, installation, whole trade and distribution, and operations and maintenance.

The installation sector is "comprised of companies that primarily develop and install .V.P.V. and other solar energy technologies, like solar space heating and cooling."[5] Solar energy systems require hundreds of components as well as the components that go into their manufacture (supply chain). Manufacturing activities may occur at facilities that build some components, but in order to be counted as a solar energy job, the employees must spend at least 50% of their time on solar-related work. "The wholesale trade and distribution sector is primarily made up of establishments engaged in the warehousing, sales, and distribution (but not installation) of solar and other ancillary products to installers and manufactures."[6] Operations and maintenance include panel cleaning, parts replacement, and system updates. Other solar employment captures academic research, government oversight, research and development, training, nonprofits, finance, engineering, consulting, law, and communications.

Businesses engaged in any or all of these functions create a measurable economic impact in South Carolina. These impacts ripple throughout the state through supply chain networks and the expenditures attributable to salaries paid to those employed in the industry. It is these direct impacts in the various sectors that are used in IMPLAN.

[5] "National Solar Jobs Census 2018," The Solar Foundation.
[6] "National Solar Jobs Census 2018," The Solar Foundation

3 MODEL DESCRIPTION

The primary purpose of a regional economic impact model is to determine the inter-relationships among the various sectors of an economy. Using these relationships, the ramifications of any economic activity can be traced through the linkages within the various economic sectors. These relationships are tabulated in an input-output table (I-O table). The I-O table is the basis for regional impact analyses. The table is constructed with data on detailed inter-industry flows throughout an economy and information on both final demands and total output. An I-O table is fundamentally an accounting relationship for an entire economy (national, state, or sub-state), with each industry represented as both a column and a row in a matrix. In simple terms, it is a set of recipes for production in a given economy. The table provides data on industry demands and supplies to all industries. To determine regional impacts, the I-O table needs to be localized. A technique utilizing location quotients is the most common method. Location quotients are a form of top-down modeling from the national tables. An important consideration in developing regional models is the determination of leakages. For example, equipment purchased outside of the economic region does not exert an impact within the region.

Economic impacts are often referred to as "multiplier effects." The direct spending on research projects represents the initial or direct impact. This direct impact value is also the input into a regional impact model. The multiplier effects are often termed "ripple effects," invoking an image of a rock tossed into a pond generating ripples across the water. These ripple effects consist of indirect and induced impacts. Regional impact models measure these impacts. There are three models commonly used to measure economic impacts: IMPLAN, RIMS II,[7] and REMI.[8]

In this report, IMPLAN (Impact Analysis for Planning)[9] was used, a model initially developed by the U.S. Department of Agriculture Forest Service in the 1970's and now maintained and marketed by a private firm. IMPLAN is a well-recognized regional impact model that is used by

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[7] RIMS II, developed by Bureau of Economic Analysis, U.S. Department of Commerce.
[8] REMI is maintained and marketed by Regional Economic Models Inc.
[9] IMPLAN Group LLC, IMPLAN System (data and software),16905 Northcross Dr., Suite 120, Huntersville, NC 28078 www.IMPLAN.com

many researchers. According to the USDA, Natural Resources Conservation Service, over 1,500 clients across the country use the IMPLAN model (2009), making the results acceptable in inter-agency analysis within the government. IMPLAN users range from federal, state, and local governments, universities, and private companies. One advantage of the current version of IMPLAN is that it is on-line and updated constantly as new data are released. The study area for this report is the state of South Carolina. Through various statistical techniques, IMPLAN localizes the impacts of spending to the study area. This means the impacts are completely within the state or the region. IMPLAN accounts for what are termed leakages, spending that leaves the state or region in the process and thus does not exert an impact.

Economic impact is reported in terms of output, income, and jobs.

1. Output: This measures the total economic activity that takes place within the economy.
2. Income: This is commonly referred to as personal income and includes employee compensation and proprietor's income.[10]
3. Jobs: Total jobs measured as full- time equivalents.

[10] Employee compensation includes wages and salaries as we as benefits such as health and life insurance, retirement and non-cash compensation. IMPLAN refers to this category as labor income.

Economic Impact Analysis – Terminology

Term	**Definition**
Economic activity	Total payments within the region.
Jobs	The number of jobs in the region supported by the economic activity associated with the project. Job estimates are not full time equivalents, but include part time positions. Seasonal jobs are adjusted to annual equivalents, e.g. four jobs for three months each equates to one job.
Income	Labor income, including wages and salaries, payroll benefits and incomes of sole proprietors. (employee compensation)
Indirect effects	Changes in sales, income and jobs in industries that supply goods and services to the businesses that sell directly to the project.
Induced effects	Changes in economic activity in the region resulting from household spending of income earned through a direct or indirect effect. For example, the project's employees live in the region and spend their incomes on housing, groceries, education, clothing and other goods and services within the region.
Total Output	Sum of direct, indirect and induced effects.
Multipliers	Multipliers capture the size of the total effects relative to the direct effects.

4 RESULTS 2018

The Solar Foundation reported total jobs in the Solar Industry in South Carolina in 2018 was 2983. Applying the same percentage distribution calculated nationally to the South Carolina total, we are able to estimate the number of jobs in each sector. These sectoral jobs became the inputs to the IMPLAN model. The table below details the 2018 survey results. It is followed by the economic impact calculations from IMPLAN.

Solar Jobs by Sector in South Carolina
2018

Sector	Jobs	Percentage
Installation and Project Development	**2114**	**64%**
Manufacturing	**356**	**12.1%**
Wholesale Trade and Distribution	**287**	**4.6%**
Operations and Maintenance	**157**	**13.9%**
Other	**69**	**5.4%**
Total	**2983**	

The Solar Foundation, *National Solar Jobs Census 2018*

Economic Impact of the Solar Energy Industry in South Carolina
2018

Impact Type	Employment	Labor Income	Output
Direct Effect	**2983**	**$175,093,531**	**$727,813,366**
Indirect Effect	**1815**	**$80,516,121**	**$244,479,884**
Induced Effect	**1532**	**$59,299,172**	**$196,716,604**
Total Effect	**6330**	**$314,908,824**	**$1,169,009,854**

The total impact of the Solar Industry in South Carolina is over $1 billion, which supports 6330 jobs. Total labor income generated by the Solar Industry and its impacts in 2018 amounted to $314,908,824. Labor income encompasses employee compensation: wages, benefits, and taxes.

State and Local Taxes
2018

$51,506,662

Local Property Taxes
2018

$19,547,302

Taxes, both state and local, generated from the economic amount are estimated to be $51,506,662 of which $19,547,302 is local property taxes. IMPLAN apportions taxes, such as local property taxes, to all of the entities associated with the economic impact of solar energy by their contribution to that impact.

5 RESULTS 2019

In this section we present the updated economic impacts from the 2019 surveys. Two major changes have occurred. First, IMPLAN has updated its model and data to incorporate the latest connections in South Carolina. Second, the survey indicates a 10.9% increase in the number of jobs related to the Solar Industry in South Carolina for a total of 3,307. The sectoral distribution did not change significantly.

Solar Jobs by Sector in South Carolina
2019

Sector	Jobs	Percentage
Installation and Project Development	**2146**	**64.9%**
Wholesale Trade and Distribution	**394**	**11.9%**
Operations and Maintenance	**152**	**4.6%**
Manufacturing	**456**	**13.8%**
Other	**159**	**4.8%**
Total	**3,307**	

The Solar Foundation, *National Solar Jobs Census 2019*

It is estimated that there were 3,307 solar-related jobs in South Carolina in 2019. These jobs pay an average of $59,609. (Note: this is labor income in IMPLAN)

Total economic activity in the state related to the Solar Industry is over $1.5 billion. Taxes, both state and local, generated from the economic amount are estimated to be an additional $58,797,544 in state and local taxes of which $23,062,144 is in property taxes.

Economic Impact of the Solar Industry in South Carolina
2019

Impact	Employment	Labor Income	Output
Direct	3,307	$197,128,349	$923,129,764
Indirect	2,257	$122,773,356	$384,184,400
Induced	1,686	$69,818,084	$231,606,688
Total	7,250	$389,719,789	$1,538,920,852

State and Local Tax Impacts
2019

Social Insurance Tax- Employee Contribution	$81,047
Social Insurance Tax- Employer Contribution	$142,843
Sales Tax	$21,099,077
Property Tax	$22,900,981
Motor Vehicle License	$440,835
Other Taxes	$4,229,028
Special Assessments	$202,693
Corporate Profits Tax	$1,537,099
Personal Tax: Income Tax	$7,613,240
Personal Tax: Motor Vehicle License	$295,342
Personal Tax: Property Taxes	$161,163
Personal Tax: Other Tax (Fish/Hunt)	$94,196
Total	$58,797,544

State and Local Taxes
2019

$58,797,544

Local Property Taxes
2019

$23,062,144

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APPENDIX

AUTHORS

Frank Hefner, Ph. D., is a Professor of Economics and director of the Office of Economic Analysis at the College of Charleston. He received his B.A. Degree in Economics from Rutgers College and his M.A. and Ph.D. Degrees from the University of Kansas. He taught at Washburn University in Topeka while he was a research assistant in the Institute for Policy and Social Research at the University of Kansas and at the University of South Carolina where he served as a research economist in the Division of Research. Dr. '" Hefner's research interests include regional economic development and forecasting. He participates in the Regional Advisory Committee of the S.C. Board of Economic Advisors. He is a past president of the Southern Regional Science Association. He has been quoted frequently in the press and has commented on economic conditions on local television and radio stations and before a number of organizations.

J. Wesley Burnett, Ph.D., is an applied economist with research interests in energy and natural resource markets and policy. Dr. Burnett studied natural resource and environmental economics at the University of Georgia, where he received his Ph.D. in 2011. He has secured eight hundred thousand dollars in external, competitively funded grants and cooperative agreements, including the National Science Foundation and the National Institute for Food and Agriculture. Additionally, he has publications in over two dozen academic journals, including Energy Economics, the Energy Journal, Energy Policy, and Resource and Energy Economics. In addition to research, Dr. Burnett teaches undergraduate microeconomic theory and graduate-level microeconomic theory applied to environmental policy. He is actively involved with numerous economic associations including the Association for Environmental and Resource Economists, the American Economic Association, and the International Association for Energy Economics Economics.

Exhibit B

Economic Impact of the Solar Industry in South Carolina by Market Segment

Frank Hefner
September 28, 2020

Economic Impact of the Solar Industry in South Carolina by Market Segment 2018

Impact	Employment	Labor Income	Output
Residential	3551	$176,663,850	$655,814,528
Non-Residential	1551	$77,152,662	$286,407,414
Utility-scale	1228	$61,092,312	$226,787,912

Note: Proportions were from Installation and Project Development Jobs by Segment. Following fixed proportions used in regional science, these proportions were applied to total impact.

Impact	Employment	Labor Income	Output
Residential	3551	$176,663,850	$655,814,528
Other	2779	$138,244,974	$513,195,326

Other includes non-residential and utility-scale.

Economic Impact of the Solar Industry in South Carolina by Market Segment 2019

Segment	Employment	Labor Income	Output
Residential	4067	$218,632,802	$863,334,598
Non-Residential	1776	$95,481,348	$377,035,609
Utility-scale	1407	$75,605,639	$298,550,645

Impact	Employment	Labor Income	Output
Residential	4067	$218,632,802	$863,334,598
Other	3183	$171,086,987	$675,586,254

Note: The Solar Foundation conducted the surveys I used in my analysis. The total number of jobs in solar is state specific. The proportion allocated to the different job sectors, manufacturing, wholesale and retail, etc., were reported at the national level. Assuming the proportions are same for each state, the proportions were used to allocate jobs into the correct IMPLAN categories to determine the economic impact in the original report. The same methodology was used in this addendum. The survey however reports the market segment proportions in the Installation and Project Development jobs. Assuming that proportion applies to the manufacturing sector, the impact across market segments was calculated. This means that since 56.1% of the installation and development jobs were attributable to residential solar, I assumed that 56.1% of the manufacturing jobs were attributable to residential. Installation and project development accounts for 64.9% of the total jobs in solar. This is a reasonable method and is used in regional impact research.

ELECTRONICALLY FILED - 2020 October 8 3:25 PM - SCPSC - Docket # 2019-182-E - Page 42 of 46

Exhibit C

FRANK L. HEFNER **9.20.2020**
Last five years

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TEACHING EXPERIENCE:

2006- present	Professor, College of Charleston
2016	Visiting Faculty, University of Economics, Bratislava, Slovakia
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1995 - 1999	Assistant Professor, College of Charleston.
1993 - 1995	Lecturer, University of South Carolina.
1988 - 1993	Assistant Professor, University of South Carolina.
1985 - 1988	Instructor, Washburn University.
1983 - 1985	Assistant Instructor, University of Kansas.
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RESEARCH EXPERIENCE:

2007 – present Director, Office of Economic Analysis, College of Charleston.

1988 - 1995 Research Economist, Division of Research, University of South Carolina

1985 - 1988 Research Assistant, Institute for Public Policy and Business Research, University of Kansas.

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2005- 2007 Chair, Department of Economics and Finance, College of Charleston

PUBLICATIONS (Refereed Journals):

Hackler, Lauren, Frank Hefner, and Mark D. Witte (2020) "The Effects of IMF Loan Condition Compliance on GDP Growth," *The American Economist*, 65 (1) 88-96.

Benefield, Justin, Frank Hefner, and Harris Hollans, (2019) "Green Certifications in Residential Real Estate: Discounted Cost Savings or Name Recognition?" *Journal of Real Estate Literature*, 27 (1) 145-158.

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CHAPTERS:

Calcagno, Peter T. and Frank Hefner. (2018) "Economic Development Tax Incentives: A Review of the Perverse, Ineffective, and Unintended Consequences," in Adam Hoffer and Todd Nesbit (editors), *For Your Own Good: Taxes, Paternalism, and Fiscal Discrimination in the Twenty-First Century*, Mercatus Center at George Mason University, Arlington, VA.: 221-241.

MONOGRAPHS:

Targeted Economic Incentives: An Analysis of State Fiscal Policy and Regulatory Conditions, with Peter Calcagno, Mercatus Center at George Mason University, 2018.

PAPERS PRESENTED:

"Using Economics Incentives to Offset Locational Negatives," Calcagno, Peter, and Frank Hefner, 87th Annual Meeting of the Southern Economic Association, Tampa, Fl., November 17-19, 2017.

"Using Economic Incentives to Offset State-Level Deficiencies," Calcagno, Peter, and Frank Hefner, 56th Meeting of the Southern Regional Science Association, Memphis, TN., March 30-April 1, 2017.

"The Empirical Relationship Between Wealth and Income Inequality in the US: 1913-2012," Blackwell, Calvin and Frank Hefner, 83rd International Atlantic Economic Society Conference, Berlin, Germany, March 22-25, 2017.

"Tax Incentives: Markets vs. Business Friendly," Calcagno, Peter, and Frank Hefner, 41st Annual Meeting of the Association for Private Enterprise and Education, Las Vegas, NV. April 3-5, 2016.

"Tax Incentives for Industrial Recruitment: A Critical Review," Calcagno, Peter, and Frank Hefner, 55th Meeting of the Southern Regional Science Association, Washington, D.C., March 31- April 2, 2016.

"Tax Incentives: Market vs. Business Friendly," Calcagno, Peter, and Frank Hefner, 53rd Annual Meeting of the Public Choice Society, March 10-12, 2016, Ft. Lauderdale, Fl.

"Does Leaving the Eurozone Mean Leaving the Euro?" Hefner, Frank and Mark Witte, 79th International Atlantic Economic Conference, March 11-14, 2015. Milan, Italy.

SPONSORED PROGRAMS AND RESEARCH

2018 Highway 78 Project Study, Co-Investigator, SC Council on Competitiveness

2016 Economic Impact of the Wild Dunes Community, Principal Investigator.

2010 Economic Forecasting, Santee-Lynches Council of Governments. Principal Investigator.

ACADEMIC SERVICE:

Referee for
Physica A 2016.
Journal of Regional Science 2011, 2013
Journal of Culture, Tourism and Hospitality Research 2011
State and Local Government Review 2010
The Annals of Regional Science 2002
Economics of Education Review 1997
The International Executive 1996
Armed Forces and Society 1993, 2001
The Review of Regional Studies 1991, 1993, 1994, 1995, 1998, 1999, 2002
Journal of Sport and Social Issues 1991
Studies in Economic Analysis: 1989, 1990, 1991
Growth and Change: 1989, 2004
1999 Conference of the Association of Marketing Theory and Practice
International Journal of Hospitality and Tourism Administration 1999
Contemporary Economic Policy 2001

Journal of Business, Industry and Economics 2004
Tourism Management 2015, 2016, 2017, 2019

Conference Participation:

58th Meeting of the Southern Regional Science Association, Washington, DC, April 4-6, 2019, session chair.
56th Meeting of the Southern Regional Science Association, Memphis, TN., March 30- April 1, 2017, discussant.
83rd International Atlantic Economic Society Conference, Berlin, Germany, March 22-25, 2017.
55th Meeting of the Southern Regional Science Association, Washington, D.C., March 31- April 2, 2016. Discussant and session chair.

SERVICE TO PROFESSION

Regional Advisory Committee, S.C. Board of Economic Advisors, 1995 - present.

COMMUNITY SERVICE

Mentor for Academic Magnet High School senior project 2011-2012, 2009-2010, 2000-2001, 2015-2016, 2016-2017.

SERVICE TO COLLEGE (College of Charleston):

School of Business

Ad Hoc Committee Student Success Center (2016-2017)
Tenure and Promotion Committee for Accounting and Legal Studies (2016-2017)
IPCMP Faculty Research Fellow Committee (2013 - 2015)
Student Development Committee (1996-1999, Chair, 2017-2018, 2018-2019)